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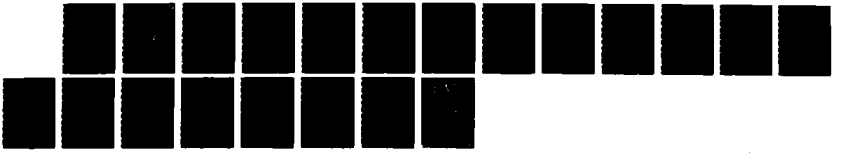

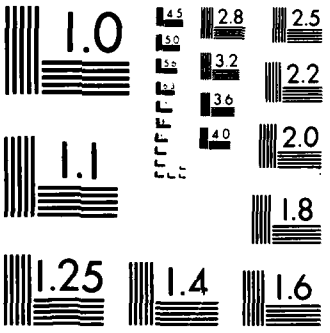

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Microcomputer-Based Organizational Survey Assessment: Applications to Training

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From: Commanding Officer, Navy Personnel Research and Development Center

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Encl: (1) NPRDC TN-87-39

1. Enclosure (1) reviews research conducted in the area of microcomputer-based organizational surveys utilizing technology developed through the Computerized Executive Networking Survey System (CENSUS) project.

2. A major thrust of enclosure (1) is the application of CENSUS technology to the field of training. Specifically it is proposed that CENSUS technology can serve as an adjunct to the development, implementation and evaluation of currently employed microcomputer-based training programs.

3. Enclosure (1) is also being published in the Journal of Business and Psychology.

John J. Pass

JOHN J. PASS
By direction

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Microcomputer-Based Organizational Survey Assessment: Applications to Training

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Linda M. Doherty, Ph.D.
Larry K. Carroll

Approved by
John J. Pass, Ph.D.
Director, Personnel Systems Department

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As sophisticated technology continues to affect organizations, a growing need for efficient, flexible and cost effective training programs becomes paramount. To cope with these increased training demands, many organizations have turned to computer-based training (CBT). The present report describes a XENIX-based IBM PC/AT Computerized Executive Network Survey System (CENSUS) that can interface with CBT training programs to enhance training quality and assess training effectiveness. The multi-user support capabilities of CENSUS allow training-related surveys to be conducted in a more efficient, accurate and reliable manner than paper-and-pencil instruments. It is this microcomputer-based multi-user system, unique to CENSUS, that may provide an alternative delivery system for microcomputer-based training programs in the future.

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MICROCOMPUTER-BASED ORGANIZATIONAL SURVEY ASSESSMENT: APPLICATIONS TO TRAINING

Paul Rosenfeld
Linda M. Doherty
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Navy Personnel Research and Development Center

ABSTRACT: As sophisticated technology continues to impact on organizations, a growing need for efficient, flexible and cost effective training programs becomes paramount. To cope with these increased training demands, many organizations have turned to Computer Based Training (CBT). The present paper describes a XENIX-based IBM PC/AT Computerized Executive Network Survey System (CENSUS) which can interface with CBT training programs to enhance training quality and assess training effectiveness. The multi-user support capabilities of CENSUS allow training-related surveys to be conducted in a more efficient, accurate and reliable manner than paper and pencil instruments. It is this microcomputer-based multi-user system, unique to CENSUS, that may provide an alternative delivery system for microcomputer-based training programs in the future.

QUALITY INSPECTED 2

Training is a ubiquitous, elaborate and often highly expensive component of modern organizations. As more sophisticated technology is introduced into organizational settings the need for better training will continue to increase (Wexley & Latham, 1981).

Recent surveys of the literature document the universality and high cost of training. In the private sector, over 90% of corporations in the United States have some form of training. In the military world, Department of Defense allocations for training exceeded $6 billion dollars in the late 1970s and continue to rise (Landy, 1985).

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As with many segments of modern business and industry, the training area has been radically altered by the computer revolution: first with the large mainframes of the 1960s and 1970s and, currently, with the increasingly powerful microcomputers of the 1980s. While some have viewed this "revolution" as another gimmick in ". . . an area (i.e., training) that seems more susceptible to gimmicks and fads than any other" (Landy, 1985, p. 283), there is little doubt that rapidly advancing computer technology will increasingly be integrated into training regimens.

It has been estimated that utilization of computer-generated information in major organizations has been growing at 50–90% per year (Fleischer & Morell, 1985). This growth is evidenced in recent surveys that found extensive use of Computer-Based Training (CBT). Kearsley and Hillelsohn (1984) reported that 42% of corporations sampled presently used CBT and 41% indicated they were considering using it in the future. A 1984 survey conducted by *Training* magazine found that almost 25% of U.S. organizations with 50 or more employees provided some form of CBT during the past year (Pribble, 1985). About 33% of professional trainers surveyed indicated that CBT would be the preferred delivery method for training in organizations within five years (Pribble, 1985).

This trend towards increased computerization of training is most pronounced in large organizations, both in the private and public sectors. Among Fortune 500 companies and government agencies surveyed by *Training* magazine, 62% currently offer their employees CBT (Trends in CBT, 1985).

Given the complexities of implementing, maintaining and evaluating training programs, it is not surprising that organizations would utilize computers. Among the advantages of CBT are speed flexibility, and the ability to custom-tailor presentations to the needs of individual trainees (Tracey, 1984). Furthermore, these advantages can be achieved without apparent decrements in the program's effectiveness. Dossett and Hulvershorn (1983) compared CBT of specialized electronics skills among Air Force personnel with a conventional training program and found identical levels of post-training achievement. CBT, however, resulted in a significant reduction in training time.

When CBT first became popular in organizations during the 1960s its noteworthy advantages were typically offset by two drawbacks: 1) computers were prohibitively expensive to own and operate and, 2) an understanding of computer technology was beyond most laymen and required highly trained specialists.

The most recent development in the computer revolution—the tremendous growth in microcomputers—has effectively eliminated these two drawbacks. As sales in microcomputers have grown, so has their cost dropped dramatically. Unlike mainframes, microcomputers are relatively easy to master and manipulate. It is not surprising, therefore, that

a recent survey of training practices found that microcomputers had supplanted mainframes and minicomputers as the most popular delivery system for training in the United States (Trends in CBT, 1985).

Though microcomputers are cheaper and easier to use than their mainframe counterparts, there has, until now, been a tradeoff: mainframes had tremendous memory capacities and the ability to communicate with a number of terminals from one central host; microcomputers did not. Microcomputers had limited memory capacity and required the awkwardness of floppy disks to run a training course. Gordon and Lee (1985) interviewed a number of executives about the future of CBT and found that the lack of storage capacity and absence of networking capability on microcomputers were seen as problematic:

> Another technological problem holding CBT back at the moment is (lack of) local area network capabilities. If you have 500 copies of a program with 10 different titles out in field offices, you don't want to deal with 5,000 floppy disks. We're waiting for local area network technology to fall into place so that we are able to access data from one copy . . . The future exists in stand-alone microcomputers, but also in terminals hooked together and able to access mainframes or minis. The problem with stand-alone micros is floppy disks. Micros are great, but floppy disks aren't; one hard disk is worth 30 floppies (pp. c25–c26).

Researchers at the Navy Personnel Research and Development Center (NPRDC) in San Diego, CA are currently working with an experimental microcomputer-based system with specially designed software that has the capacity to support up to sixteen terminals. Combining this multiuser capacity with the hard disk configuration of the IBM PC/AT host computer results in a system that has the potential to significantly advance the current state of microcomputer-based training. The remainder of this paper, describes this Computerized Executive Networking Survey System (CENSUS), reports several initial tests of the system, and proposes applications of CENSUS relevant to training and other business-related areas.

CENSUS: A DESCRIPTION

As its name implies, CENSUS originally was developed as a way to quickly, accurately, and economically survey the attitudes of the Navy civilian workforce. Traditionally, policy makers needing to survey the civilian workforce have used paper and pencil instruments. However, when survey results are needed quickly, paper and pencil instruments can prove cumbersome. The data must be reduced from raw form and transferred to coding sheets for computer analysis, a process that is both time

consuming and error prone. Although the use of optically scannable answer sheets eliminates some of these problems, data still may be misplaced, answers left blank or incorrectly completed, and most importantly, the analysis phase remains separated in time and location from the data collection. CENSUS automates these functions.

CENSUS: SYSTEM CONFIGURATION

CENSUS is configured using existing microcomputer technology, and utilizes software written in the "C" language by NPRDC programmers for the specific task of conducting computerized surveys. The host computer is an IBM PC/AT configured with three megabytes of memory and equipped with two CONTROL SYSTEMS 8-port serial boards. In conjunction with IBM's XENIX operating system (version 2.0), the hardware configuration allows up to sixteen terminals to communicate with the host directly, or remotely through a modem (See Appendix for additional information).

The features of the CENSUS system configuration provide great flexibility. An organizational survey can be keyed directly into the host microcomputer and be completed by as many as sixteen users simultaneously. The system allows the users to be located in the same site as the host (hardwired) or at remote sites using modems and commercial phone lines. Although multiple individuals may be surveyed simultaneously, each user works at his/her pace, and is unaffected by the responses or response times of the other users.

The individual responses are stored by the host in an answer file given a file name of the user's ID. A free-format screen definition allows up to ten answers per question and up to nine multiple answers at one time. Thus, the display possibilities are numerous; presently multiple-choice and Likert scales have been tested. In the future, graphics will be integrated into the question format as well as used in providing feedback to the user. Furthermore, the system can check an ID number against the user file to determine its validity, and can link preexisting information about the user (e.g., age, income, rank) with his/her responses. If the ID is valid, the user is allowed to take the survey. If an invalid ID is entered, the user is denied access to the survey and the communication line disconnects. The responses to both demographic questions (e.g., age, years of service) and attitudinal questions (e.g., "To what extent is creativity encouraged in your organization?") are kept in ASCII files making them appropriate for subsequent data analyses.

The multi-user capability of CENSUS, is perhaps its most significant advance; one that appears generalizable to a number of different areas where microcomputer technology is currently applied. For while micro-

computers have been used with increasing frequency to administer psychiatric assessments (Carr & Ghosh, 1983; Lukin, Dowd, Plake, & Kraft, 1985), standardized psychometric tests (Beaumont, 1981) and substance abuse questionnaires (Skinner & Allen, 1983), none of these applications had the multi-user capability developed for CENSUS: a single microcomputer host accurately administering a survey instrument to many users simultaneously.

FIELD TESTS

CENSUS has effectively overcome the time delay and transcription error difficulties associated with paper-and-pencil surveys. In a recent field demonstration in San Diego, CA a survey was given to 120 individuals, the data analyzed, and a briefing prepared based on the results with graphs and text, all within a 24 hour period. In August, 1985 a questionnaire on attitudes toward potential changes to the retirement system was administered to over 300 Navy civilians in Washington, D.C. CENSUS was compared to a paper and pencil version of a survey consisting of 60 questions on attitudes toward proposed changes to the civil service retirement system. Previously, Kiesler and Sproull (1986) and Erdman, Klein, and Geist (1983) found that when comparing electronic surveys to paper mail surveys, there were fewer completion mistakes, fewer blank items, and fewer refusals to answer questions in the electronic survey. These issues were addressed in the comparison between the two versions of the retirement survey.

The paper and pencil survey on retirement was administered to 46 individuals at a Navy research laboratory located in Maryland during the last week in August, 1985, while an automated version was being administered to a sample of employees in the Washington, DC area in 16 activities (N = 307). Comparisons between a comparable sub-sample of the automated group (N = 27) and paper and pencil group were made to assess the error rate of the respondents on the paper version (e.g., multiple responses and inappropriate branching). Results indicated that 3% of the total responses were in error for the paper and pencil survey, with half of those errors representing incorrect branching, i.e., individuals who did not branch properly when instructed to do so. There were essentially no errors in recorded responses or hardware, software or communications malfunctions for the computerized survey group.

In August, 1986, workers at the Naval Air Rework Facility (NARF) in San Diego participated in a study comparing computerized questionnaire assessment with traditional paper and pencil methodology. Male civilian employees working in several "blue collar" jobs at the NARF were randomly selected for participation in this study. Letters were sent to the

selected individuals indicating that civilian headquarters was interested in attitudes toward critical civilian jobs for future manpower planning. Upon arrival at the testing center, participant's names and social security numbers were checked against a master list, after which they were asked to complete a survey containing a modified version of the Job Description Index (Smith, Kendall, & Hulin, 1969) as well as other job-related questions. The subjects were randomly assigned to either the paper and pencil (N = 33) or CENSUS (N = 43) groups. The results showed that nearly equivalent scores on the job satisfaction measures were obtained for paper and pencil and CENSUS groups. Analysis of Variance indicated that the CENSUS group did not significantly differ from paper and pencil for overall job satisfaction, growth satisfaction, security satisfaction, pay satisfaction, and social satisfaction (all p's >.20). When the subscale scores were summed to obtain an overall measure of job satisfaction, the means for CENSUS ($\bar{X} = 49.53$) and paper and pencil ($\bar{X} = 48.78$) groups were virtually identical. Though the job satisfaction scores were equivalent, those who completed the survey on CENSUS rated the experience as more enjoyable ($\bar{X} = 3.42$), than those who completed the paper and pencil survey ($\bar{X} = 2.76$), $F, (1/74) = 4.85$, $p < .04$.

CENSUS: TRAINING APPLICATIONS

Among the factors that impact on the success or failure of a training program are the attitudes of trainees towards their program, job and organization. Indeed, definitions of training often include attitude change as a goal:

> Training is a set of planned activities on the part of an organization to increase the job knowledge and skills, or to modify the attitudes and social behavior of its members in ways consistent with the goals of the organization and the requirements of the job (Landy, 1985, p.263).

Thus, during the development, implementation, and evaluation phases of a training program, managers may need to survey the attitudes of the trainees themselves. In addition to determining whether a positive attitude change has occurred, attitude assessment can help managers establish deficiencies in current training, uncover areas where training is perceived as lacking, and obtain feedback about the acceptance of a new training delivery system.

According to Wexley and Latham (1981), assessing the post-training attitudes of employees is an important facet of determining training effectiveness. In training terminology, this attitude assessment is commonly referred to as reaction criteria and includes items designed to measure how well the trainees liked the program, trainer, training techniques, etc.

However, assessing attitudes accurately is a task social scientists have struggled with for over half a century (Tedeschi, Lindskold, & Rosenfeld, 1985, chapter 6). The manager attempting to assess user attitudes toward a training system is faced with many of the same difficulties as professional attitude researchers. The manager must contend with the difficult and tedious process of question construction and analysis with which he or she has little experience. Additionally, the validity of the questionnaire may be affected by multiple or missing responses or lack of user interest.

Many of these drawbacks to attitude measurement can be reduced through CENSUS. The system is sufficiently adaptable so that it may be interfaced into existing microcomputer-based CBT programs, or added to a noncomputer-based training system. Compared to the costs of the training program, the expense of implementing CENSUS would be minimal. While the typical discussion of microcomputer networks revolves around linking a number of microcomputers together, CENSUS requires only one microcomputer host with the users working on "dumb" terminals, which are substantially lower in cost than stand-alone micros. Furthermore, existing stand-alone microcomputers could be integrated into the CENSUS system. Thus, even in large organizations, CENSUS could quickly, efficiently, and economically present, monitor and analyze a variety of training-related attitude surveys.

BRANCHING: SURVEYS CUSTOMIZED TO INDIVIDUAL NEEDS

The previous discussion of CENSUS' capabilities did not fully capture the system's potential. CENSUS was described, essentially, as a "survey in a box," that is, a computerized mimic of a paper and pencil survey. However, an exact mimicry does not fully exploit the decision making capacities of computer technology. Besides its ability to provide quick feedback, accurate record keeping, monitoring of inappropriate answers, elimination of missing responses, and sophisticated data analyses, CENSUS can customize surveys based on the user's personal characteristics, or responses to previous questions. This feature, called branching, has been used extensively by researchers in the Computerized Adaptive Testing (CAT) area. Branching presents the most appropriate or unique set of questions for each user, while eliminating the presentation of inappropriate or irrelevant questions characteristic of lengthy paper and pencil surveys.

Branching allows the recipients of differing training programs to complete a survey custom-tailored to their previous experiences. Additionally, their responses on previous questions determine the pattern of subsequent questions. If a trainee indicates s/he is single on a "marital status" question, then all the demographic questions pertaining to

married individuals are bypassed. If individuals are displeased with the coursework of the training program, the branching feature could ask additional specific questions to determine where the discontent is. Another user, indicating satisfaction with the coursework, would not be presented with these additional questions. The reduction in administration time and user boredom obtained from CENSUS' branching features should be readily apparent.

The branching capabilities of CENSUS have been successfully demonstrated in previous field tests. In the job satisfaction study conducted at the Naval Air Rework Facility, we asked a number of questions relating to training previously received in the job. Individuals who responded to the lead question that they had received no training were branched to the next applicable question. Those who indicated they weren't in the military reserves were spared the tedium of responding to qeustions which did not apply to them. The entire branching presentation is transparent to the user. The user is unaware that branching is taking place and that others are being presented with different questions.

TOWARDS THE FUTURE: AN AUTHORING SYSTEM

One of the attractions of CBT has been the availability of authoring systems—interactive software packages which allow managers to design their own computerized training programs. Presently, the most sophisticated of these systems are available on mainframe computers with microcomputer-based authoring systems rapidly becoming more advanced (Pribble, 1985).

While developing an attitude survey is not nearly as complex as designing a training program, it certainly is a task requiring much specialized knowledge. Thus, the manager seeking to survey the attitudinal impact of a training program would be greatly aided by a survey-generating authoring system.

We are currently in the initial phases of developing authoring system software that would run on CENSUS. As presently envisioned, the system will consist of an interactive software program that provides a manager untrained in questionnaire design with a prompting, retrieval and feedback system to produce reliable and useful surveys, specify random and representative samples, and provide necessary data analyses. As methods for developing questions become more precise and as data banks of questions and responses are established, it will be possible for managers to develop questionnaires independently from experts and interactively with the computer.

The authoring system will consist of two components—a menu driven control system that includes an editor and format specifier, and a

data base that includes survey data from previous questionnaire administrations and standardized questionnaires in general. Hence, the quality of training related surveys (e.g., reaction criteria, self-reports, behavioral questionnaires) will be improved and their applicability to areas such as program evaluation and organizational communication made easier.

A DIRECT LINK: CENSUS AS THE TRAINING DELIVERY SYSTEM

In its current usage, CENSUS appears most applicable as an adjunct to a training program: it can assess employee attitudes from pretraining to post-training program evaluation phases. However, with modifications, CENSUS could be used as a delivery system for a microcomputer-based CBT system. The hard disk storage system of the IBM PC/AT eliminates the awkwardness of floppy disks and CENSUS' ability to support multiple users achieves the networking capabilities that users of CBT have noted is a capability lacking in current microcomputer CBT systems. Obviously, modifications will be required to accommodate the steep memory needs of large training programs, but in principle, CENSUS provides the "missing link," i.e., microcomputer based networking, that is necessary for CBT to function effectively and economically on microcomputers. Furthermore, CENSUS-based networking exploits the more cost-effective "dumb" terminals as compared to the linking of stand-alone microcomputers in conventional Local Area Networks (LANs).

CENSUS: APPLICATIONS TO THE BUSINESS SECTOR

The applicability of the CENSUS system to business and organizational settings is not limited to the training area which has been the focus of this paper. The CENSUS system's capacity as a quick and reliable survey vehicle can also be utilized by managers wishing to conduct organizational surveys as part of an overall organizational feedback system. Historically, surveys have been a device for tapping attitudes and opinions of employees in organizations. However, there often was more concern for the measurement issues of the instrument itself than for the informational value or feedback aspects of the system. Currently, as popular management books advocate, there is an emphasis on employee involvement in decision making at all levels in organizations. This could lead to a resurgence in the use of surveys, as managers need to better understand the attitudes, beliefs and opinions of employees prior to making decisions that affect their working lives (Hinrichs, 1985). By integrating computerized survey technology into computerized management information systems, timely and comprehensive objective feedback may be

provided that would improve organizational communication, an essential ingredient in the tools of modern management. A recent article highlights the importance of survey feedback within an organization:

> . . . studies also indicate that survey feedback is highly valued by employees. They appreciate management's "closing the loop" on the survey process and can be highly motivated to implement positive changes . . . Surveys have become a way to generate employee commitment and involvement (Employee involvement through survey feedback, 1986, p. 1).

Employee involvement in the CENSUS system is evidenced by the interest in receiving feedback and the anticipation for future surveys by respondents of our previous surveys. By automating reports of results, policy makers, managers, and employees alike will be able to have meaningful and timely feedback on the attitudes of the workforce. Involvement in the organization by individuals at all levels should improve by incorporating the technology of presentation and communication methods. These feedback methods would include improved information displays, such as the enhanced use of graphics (Fienberg, 1979). In addition, a true feedback system will be established when managers become involved in developing questionnaires and accessing the data base through easy to use menu-driven computer programs. By evaluating the needs of managers, more effective feedback mechanisms will be developed to provide input to future surveys, and will be the final component in the automated survey system.

Because many organizations do not have access to XENIX-based equipment but do use stand-alone microcomputers for a number of purposes (e.g., word processing, data-base management), an MS-DOS-based prototype of the CENSUS system called MASQ (Microcomputer-based Assessment, Surveys, and Questionnaires) has recently been developed by Larry Carroll, one of the present authors. This program allows a microcomputer-based survey to be developed, run, stored, and analyzed on any IBM or IBM-compatible microcomputer, including portables such as the IBM convertible. Although MASQ does not have the multi-user features of CENSUS its presentation of survey items to the user is identical to that of the CENSUS system. In short, MASQ is an MS-DOS mimic of the XENIX-based CENSUS system. Thus, a manager could conduct an organizational survey of limited scope without the necessity of purchasing additional equipment. Larger scale applications such as training are more suitable for administration using CENSUS. We are currently conducting a comparative test of CENSUS and MASQ as delivery mechanisms for organizational surveys relating to organizational communication, decision making, management perceptiveness, etc. A future article in this journal will describe this work in greater detail.

CONCLUSIONS

Although still in a developmental stage, CENSUS provides a mechanism to improve the assessment of organizational programs such as training. The current system is capable of providing an economical and reliable way of conducting and analyzing organizational surveys, which are important components in many businesses and organizations and play an important role in the implementation of training programs. Compared to the costs of training program implementation, the expenses entailed by CENSUS are minor and well-justified given the potential benefits and savings that training programs can accrue. By advancing the technology of survey systems to keep pace with the rapid advances in the technology of training delivery systems, organizations can more effectively cope with the ever-growing demands for better training.

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APPENDIX

CENSUS SYSTEM: EQUIPMENT/VENDOR LISTING

APPENDIX
CENSUS SYSTEM: EQUIPMENT/VENDOR LISTING

A. International Business Machines Corporation
   Boca Raton, FL 33432
   1) PC-AT Microcomputer configuration
      1.2 Mb Floppy drive
      30 Mb Hard drive
      3 Mb memory
      Enhanced graphics adapter
      Enhanced color monitor
   2) XENIX Operating System Version 2.0 (Unix system V)

B. Control Systems Corporation
   2855 Anthony Lane
   Minneapolis, MI 55418
   3) 8 port aysynchronous card

C. Hayes Microcomputer Products, Inc.
   5923 Peachtree Industrial Blvd.
   Norcross, GA 30092
   4) Hayes 1200B smartmodem

D. QUME Corporation
   2350 Qume Drive
   San Jose, CA 95131
   5) QVT211GX Graphics Terminal

E. Navy Personnel Research and Development Center
   271 Catalina Blvd
   San Diego, CA 92152-6800
   (619) 225-2396
   6) CENSUS Survey Software

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